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I, JONNE YABSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PS 0157 for a patent by THALES UNDERWATER SYSTEMS PTY LIMITED as filed on 25 January 2002.

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Sixth day of February 2003

J R Yabsley

JONNE YABSLEY
TEAM LEADER EXAMINATION
SUPPORT AND SALES

AUSTRALIA

PATENTS ACT 1990

PROVISIONAL SPECIFICATION

FOR THE INVENTION ENTITLED:-

"ELECTRONICS CARRYING MODULE"

The invention is described in the following statement:-

ELECTRONICS CARRYING MODULE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed, in general, to the field of electronics packaging. Embodiments of the invention have applications in marine seismic exploration by providing an electronics-carrying module for a seismic data acquisition cable and will be described hereinafter predominantly with reference to this application. However it will be appreciated that this invention is not limited to this particular field of use, for example the invention is also useful in other fields of endeavor such as overhead transmission lines or any anything that embodies electronics in a continuous cable.

2. Description of the Prior Art

At present, there are two modes of data acquisition arrays or systems for conducting a marine seismic survey. One mode is to adopt a distribution Ocean Bottom Cable data acquisition array that uses mostly 12-24 channels data acquisition, with digitized data transmission in the cable and recording in a central station.

Another mode of data acquisition arrays used in marine geophysical imaging is typically referred to in the art as "streamer cable"

or "towed array" or simply as "streamer". Streamers are usually towed behind a sea-going vessel or submarine, and sense acoustic signals originating from a variety of underwater sources. In undersea warfare applications the signal may emanate from other vessels whose natural mechanical actions tend to radiate sound, which in turn may propagate considerable distances through open seawater. This is an example of "passive" detection using streamers. Since the streamers are towed behind a vessel, they are made to have a neutral buoyancy which is typically provided by including a filling liquid or gel that has a density less than sea water, or by using plastic or glass microspheres embedded in a solid or semi-solid material.

Alternatively, a source of acoustic energy may be used to "insonify" the general vicinity around the streamers which are used to receive reflected acoustic signals from natural or artificial objects in the sea. This particular mode of sensing is important in the detection and imaging of sub-sea structure which in turn is the most effective means presently known for oil exploration. Such streamers are commonly known as "seismic streamers".

In order to perform seismic surveys, a seismic streamer needs to be towed in the water behind a marine seismic vessel. The vessel tows acoustic energy sources such as air guns to generate energy for penetrating subsurface geologic formations, and streamer support hydrophones for detecting energy reflected from the subsurface formations. The streamers typically comprise arrays of hydrophones, buoyancy material, electronic circuitries, such as preamplifiers, analog-to-digital converters, electro-optic modulators, data acquisition

units and etc., power lines, data transmission lines (electrical wires and/or optical fibres), and strength members.

For three dimensional seismic surveys, several streamers of a number between two and twelve or more are deployed simultaneously, each such streamer extending usually between three and twelve kilometers in length. Due to its extreme length, the streamer is divided into a number of separate sealed elongate "sections" or "modules" that can be decoupled from one another and are interconnected end to end to make up the streamer. This module-like structure of the streamer is also very similar to Ocean Bottom Cables. The modules are connected together through connectors which form end fittings in the module ends which physically secure the modules together and also provide for electrical/optical connections between modules so that data and power can pass freely the length of the streamer.

In the past, the electronic circuitries formed on printed circuit boards (PCBs) were physically housed in metal canisters located within or between the modules in the streamer. Being metal and containing electronic components, the canisters were relatively heavy. Thus, the canisters were made large (on the order of 4 inches in diameter and 12-15 inches in length) and spacious inside to give the canisters an overall near-neutral buoyancy and a volume large enough to accommodate large rigid PCBs.

Unfortunately, the inter-module canisters had several significant disadvantages. First, the streamer section interconnection must be broken to allow for access to canister electronics for both

maintenance and replacement. The breaking of the inter-section connection presents large operational down-time and handling risks, particularly if performed in a deployed state. Second, the canister is a large rigid design which gives rise to a mismatch in mechanical handling characteristic to the flexible streamer sections. This creates a handling difficulty and thus likely to create mechanical failure points. Third, the system cost is governed partly by the number of canisters needed. Each canister with its associated electronics and connectors is a large cost assembly. Thus a system which requires a lesser number of canisters will be more cost efficient.

U.S. Pat. No. 5,400,298 subsequently disclosed an integrated module for a towed hydrophone streamer that eliminates the inter-module canisters by providing a distributed network of interconnected watertight electronics housings or "cans" spread throughout each integrated module of the streamer. Nevertheless, for system maintenance and replacement of failed PCBs, the integrated module of U.S. Pat. No. 5,400,298 can no longer support "easy access" to the PCBs, which is a distinctive feature of the inter-module canisters.

Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of common general knowledge in the field.

It is an object of the present invention to overcome or ameliorate at least one of the disadvantages of the prior art, or to provide a useful alternative.

SUMMARY OF THE INVENTION

The preferred embodiment of the present invention is applicable to both ocean bottom cables and seismic streamers as well as to both solid and liquid-filled cables.

The preferred embodiment provides an electronics-carrying module with a reduced outer dimension as compared to a conventional canister, but still having a spacious curved space inside for carrying bendable, wrap-around circuitry.

The preferred embodimen further provides the above mentioned electronics-carrying module with easy access to the wrap-around circuitry carried inside the electronic carrier. For example, the distributed electronics can be removed or serviced without decoupling or removing the electronics-carrying module, which is a distinctive feature of the preferred embodiment of the present invention not available in the prior art.

Additionally, a preferred embodiment of the present invention provides an electronics packaging solution which accommodates an un-interrupted central strength member running along the entire length of an active section of seismic data acquisition cables.

In accordance with a first aspect of the present invention there is provided an electronics-carrying module in a seismic data acquisition cable including:

an electronics carrier having access means for providing an easy-to-reach access to a wrap-around circuitry fitted inside a curved space within said electronics carrier;

a pair of rigid end-fittings spaced apart axially by said electronics carrier for connecting to a section of said seismic data acquisition cable; and

an axial hole formed in said electronics carrier and said rigid end-fittings defining said curved space between said axial hole, said access means and said rigid end-fittings, said axial hole is formed for accommodating a cable with an un-interrupted strength member along said seismic data acquisition cable through said electronics-carrying module.

access meanscurved spacecurved spaceaccess means

According to a second aspect of the present invention there is provided an electronics carrying module including:

a carrier defining a space for housing of electronics;

selectively removable access means disposable onto said carrier so as to provide access to said space;

a pair of end–fittings spaced apart axially by said carrier for connection of said module to a section of a cable;

said cable having an axially extending strength member; and

a hole disposed along said module between said end-fittings, said hole being sized so as to accommodate threading of said cable through said module such that said strength member extends axially through said module;

said access means being operable to provide access to said space without decoupling or removing the module from the cable.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment will now be described, by way of example only, with reference to the accompanying drawings in which:

FIG. 1 is an illustration of a perspective view of an embodiment of the electronics-carrying module of the present invention.

FIG. 2 is an illustration of a perspective view of another embodiment of the electronics-carrying module of the present invention.

FIG. 3 is an illustration of a partial perspective view with the embodiment of FIG. 1 of the seismic data acquisition cable of the present invention.

FIG. 4 is an illustration of a partial perspective view with the embodiment of FIG. 2 of the seismic data acquisition cable of the present invention.

FIG. 5a is an illustration of a layout view of an embodiment of the wrap-around circuitry of the present invention.

FIG. 5b is an illustration of a layout view of an alternate embodiment of FIG. 5a.

FIG. 5c is an illustration of a layout view of another alternate embodiment of FIG. 5a.

FIG. 6 is a general overview of an illustrative seismic streamer assembly towed behind a seismic vessel.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Some sample embodiments of the seismic data acquisition cable of the present invention will now be described in greater detail. Nevertheless, it should be recognized that the present invention can be practiced in a wide range of other embodiments besides those explicitly described, and the scope of the present invention is expressly not limited except as specified in the accompanying claims.

Moreover, while the present invention is illustrated by a number of preferred embodiments directed to seismic streamers, it is not intended that these illustrations be a limitation on the scope or applicability of the present invention. Apart from seismic streamers, the present invention is also applicable to other applications, for example ocean bottom cables and to both solid and liquid-filled type of cables. Further, various parts of the present invention have not been drawn to scale. Certain dimensions have been exaggerated in relation to other dimensions in order to provide a clearer illustration and understanding of the present invention.

Referring initially to FIG. 1, illustrated is a perspective view of an

embodiment of an electronics-carrying module of the present invention. The electronics-carrying module having formed an axial hole 100 close to or in the center of the electronics-carrying module. The electronics-carrying module further comprises an electronics carrier 101 and a pair of rigid end-fittings 102 spaced apart axially by the electronics carrier 101. The electronics carrier of the present invention is composed of an inner tube 103, in either a cylindrical or polygonal shape, encompassed with an access means for providing an easy-to-reach access to a curved space 104 (104a and 104b) defined in between the inner tube 103, the access means and the pair of rigid end-fittings 102. Wherein, the curved space 104 is used in the present invention as a spacious room for placing things that need to be carried by the electronics-carrying module. Accordingly, the inner tube 103 encloses a major portion of the axial hole 100 and has at least one opening 105 formed thereon. The pair of rigid end-fittings 102 encloses the remaining portion of the axial hole 100.

The access means of the present embodiment comprises a first fractional fluid-resistant tube 106 fixed between the pair of rigid end-fittings 102 and a second fractional fluid-resistant tube 107. The second fractional fluid-resistant tube 107 secures and attaches to the first fractional fluid-resistant tube 106 by means of sealing, and it can be de-attached from the first fractional fluid-resistant tube 106 by removing the sealing means. An elastomer ring 108 such as a rubber ring together with some securing means selected, for example, from the group consisting of screw, clip, band, magnet, suction and adhesive material such as glue, make up the sealing means which secures and seals the second fractional fluid-resistant tube 107 to the first fractional

fluid-resistant tube 106. As shown in FIG. 1, the present embodiment of the present invention uses a screw 109 at each corner to do the securing job. Therefore, by using such combination, a waterproof and gap-free closure can be ensured. Moreover, the elastomer ring 108 used in the present invention can be either replaced or accompanied by any waterproof sealant for maintaining or reinforcing the sealing..

The curved space 104 defined earlier is shown to be divided into two parts, 104a and 104b in the present embodiment in FIG. 1, one in the first fractional fluid-resistant tube 106 and the other in the second fractional fluid-resistant tube 107. The two fractional fluid-resistant tubes make up the access means which define the curved space 104 together with the inner tube 103 and the pair of rigid end-fittings 102. The first fractional fluid-resistant tube 106 shown in FIG. 1 is larger in volume than the second fractional fluid-resistant tube 107. However, in other embodiments the first fractional fluid-resistant tube 106 is smaller in volume than, or equal in volume to, the second fractional fluid-resistant tube 107.

Referring now to FIG. 2, illustrated is a perspective view of another embodiment of the electronics-carrying module of the present invention with an alternate access means design.The electronics-carrying module having formed an axial hole 200 closeto, or in the center of, the electronics-carrying module. The electronics-carrying module further comprises an electronics carrier 201 and a pair of rigid end-fittings 202. The electronics carrier of the present embodiment is also composed of an inner tube 203, in either a cylindrical or polygonal shape, encompassed with another access means

for providing easy-to-reach access to a curved space 204 defined in between the inner tube 203, the access means and the pair of rigid end-fittings 202. Accordingly, the inner tube 203 spaces apart the pair of rigid end-fittings 202 axially, encloses a major portion of the axial hole 200 and has at least one opening 205 formed thereon. The pair of rigid end-fittings 202 encloses the remaining portion of the axial hole 200.

The access means of the present embodiment is a movable open-ended cylinder 206 having a diameter slightly larger than any part of the seismic data acquisition cable of the present invention, in particular larger than the diameter of the rigid end-fittings 202. So that, the movable open-ended cylinder 206 can be slid away from the inner tube 203 to expose the curved space 204. The movable open-ended cylinder 206 is attached to the pair of rigid end-fittings 202 also by some means of sealing and can be de-attached by removing the sealing means.

An elastomer ring 207 such as a rubber ring together with some securing means selected from the group consisting of, for example, screw, clip, band, magnet, suction and adhesive material such as glue, make up the sealing means which secures and seals the movable open-ended cylinder 206 to the pair of rigid end-fittings 202. As shown in FIG. 2, the present embodiment uses at least one screw 208 at each end of the movable open-ended cylinder 206 to fulfil the securing job. Therefore, by using such combination, a waterproof and gap-free closure can be ensured. Moreover, the elastomer ring 207 used in the present embodiment can be either replaced or accompanied by any waterproof sealant for maintaining or reinforcing the sealing.

Referring now to both FIGS. 3 and 4, illustrated are partial perspective views with the embodiment of FIG. 1 and 2 of the seismic data acquisition cable of the present invention respectively. FIG. 4 further shows the movable open-ended cylinder 206 of FIG. 2 being sliding away from the inner tube 203 to expose the curved space 204. The movable open-ended cylinder 206 of FIG. 4 can also be slid in a direction opposite to the direction 220 shown. The curved space, 104a and 104b of FIG. 3 and 204 of FIG. 4, is used in the present embodiments as the spacious room for placing electronic components such as wrap-around circuitry 300 that needs to be carried by the electronics-carrying module in the seismic data acquisition cable. The wrap-around circuitry 300 wraps around the inner tube, 103 of FIG. 3 and 203 of FIG. 4, for making a full usage of the curved space inside the electronics-carrying module and couples to a cable 400 that runs through the axial hole, 100 of FIG. 3 and 200 of FIG. 4, for both power and signal transmission. The wrap-around circuitry 300 is coupled to the cable 400 through the openings, 105 of FIG. 3 and 205 of FIG. 4, on the inner tube, 103 of FIG. 3 and 203 of FIG. 4, by means of wiring and/or pin-socket connectors at the openings, 105 of FIG. 3 and 205 of FIG. 4. The wrap-around circuitry 300 is secured to the inner tube, 103 of FIG. 3 and 203 of FIG. 4, by glue or any other securing means mentioned earlier, or by the pin-socket connectors themselves. Moreover, the wrap-around circuitry 300 can be any, or any combination of, electronics circuitry/module whether well known in the art or not, amplifying circuitry, data acquisition unit, analog-to-digital converter, multiplexing circuitry, active control circuitry, power supply circuitry and data transmission unit, just to name a few. Further, the circuitry 300 may consist of, or include, sensors as described in U.S. Patent No.

5,400,298, the contents of which are hereby incorporated in their entirety by way of cross-reference.

The cable 400 shown in both FIGS. 3 and 4 has a distinctive feature of an integrated transmission cable and strength member structure. It provides an electronics packaging solution which accommodates an un-interrupted central strength member running along an entire length of an active section of the seismic data acquisition cable of the present invention. The cable 400 normally comprises a local power and telemetry section, a global strength section, and a global power and telemetry section 410. Wherein, "global" means un-interruptly running along the entire length of the active section, and "local" means been sub-split along the active section wherever needed.

The preferred embodiments of the cable 400 shown in both FIGS. 3 and 4 comprise a cable protective jacket 401 and having at least one strength member 402, or referred to as the global strength section, running along the entire length of the cable 400 underneath the cable protective jacket 401. The strength member 402 is used to carry pulling forces generated by a towing object, it has an outer coating jacket which surrounds a metallic cord, synthetic cord, glass reinforced plastic, glass/resin composite structure, synthetic braid or any other material/composition that serves the same function. Intermediate the cable protective jacket 401 and the strength member 402 there is formed a plurality of integrated signal and power transmission lines 403, or referred to as the local power and telemetry section. The integrated signal and power transmission lines 403 comprise metal wiring such as copper wires. The copper wires sub-split along the cable 400 in

particular at the openings, 105 of FIG. 3 and 205 of FIG. 4, for providing power to and signal transmission to and from the wrap-around circuitry 300. The global power and telemetry section 410 normally comprises at least one global power line 411 and at least one optical fibre 412, which can all be placed within the strength member 402, as shown in the drawings, or by its side, like the local power and telemetry section.

Referring now to FIG. 5a, 5b and 5c, illustrated are layout views of some sample embodiments of the wrap-around circuitry of the present invention. The wrap-around circuitry comprises a first rigid circuit board 301 with a connection (not shown) for connecting the wrap-around circuitry to the cable by means of wiring and/or pin-socket connectors, and a second rigid circuit board 302 joined to the first rigid circuit board 301 by a connection means 303. The wrap-around circuitry further comprises a plurality of other rigid circuit boards 304 joined one to another and to the second rigid circuit board 302 by the same connection means 303. Any of the connection means 303 can be a bendable conductor selected from the group consisting of a bunch of wires in a ribbon cable and a flexible printed circuit board, or a fixed connector such as a pin-socket connector. With such connection means the rigid circuit boards can be spread across, stacked up one on top of another or the combination of spreading across and stacking up. Hence, a variety of wrap-around circuitry structures can be obtained as long as the wrap-around circuitry can fit into the curved space of the electronics-carrying module. Moreover, the circuit boards used to construct the wrap-around circuitry of the present invention are not restricted to any rigid shape. The circuit boards can be flexible printed circuit boards as well, even with only one board.

Finally, referring to FIG. 6, illustrated is an elevational view representing the active section 600 of a seismic streamer 500 of a preferred embodiment of the seismic data acquisition cable of the present invention in operation. A seismic vessel 700 tows the seismic data acquisition cable, or referred to as the seismic streamer 500 in the present embodiment, by way of a tow cable 710. The seismic vessel 700 also tows an array of acoustic energy sources 720 such as air guns to generate energy for penetrating subsurface geologic formations, and the seismic streamer 500 supports a number of the repeated active sections 600 by joining one termination 610 to another for detecting energy reflected from the subsurface formations.

The active section 600 of the present embodiment comprises, first, a plurality of sensor group assemblies 620. Each sensor group assembly 620 further comprises a plurality of sensor device carriers 630 distributed in a spaced-apart relationship along each of the sensor group assemblies. Moreover, each of the sensor device carriers 630 has a central axial hole formed therein for allowing the cable 400 to run through, and each carrying at least one sensor device. The sensor device may include, for example, a hydrophone of the type commonly used in marine seismic survey of the present embodiment. Such hydrophones include but are not limited to those which operate using fibre optics or piezoelectric phenomena. The sensor devices may also include at least one non-acoustic sensor, for example, thermal sensors, pressure sensors, magnetic heading sensors, gravitational sensors or velocity sensors such as geophones.

Second, a plurality of the electronics-carrying modules 640

mentioned earlier in FIG. 1 or 2 are mounted onto the tow cable 710. The electronics-carrying modules 640 are distributed along the active section 600 of the seismic streamer 500 and in between two sensor group assemblies. Third, the cable 400 of FIGS. 3 and 4 is positioned in the active section 600 running along the entire length of the active section 600 through the sensor group assembly 620 and through the axial hole in each of the electronics-carrying modules 640. Fourth, an outermost protective layer 650 is disposed around the cable 400 and around the sensor group assembly 620 for protecting the cable and the sensor group assembly from the outside environment. Moreover, the outermost protective layer can also cover over the electronics-carrying module for the same protection purpose in the present invention but not in the present embodiment. The outermost protective layer 650 is formed by extruding a material from a group containing polyurethane, polyethylene, polycarbonate, polyacrylate and similar materials for avoiding sea-water leakage. Fifth, a metal ring 660 for clamping an end of the outermost protective layer 650 to the rigid end-fitting of the electronics-carrying module 640. Sixth, a buoyant segment 670 is formed to fill the void underneath the outermost protective layer 650 for providing a desired buoyancy level. The buoyant segment 670 can be a liquid material such as hydrocarbon fluid, or a solid material such as polyurethane composite, or any material in between liquid and solid state such as a gel type material. The buoyant segment 670 is normally not needed if the seismic data acquisition cable of the present invention is not the seismic streamer 500 of the present embodiment but something else, such as an ocean bottom cable. A layer of strength reinforcing member (not shown) over the outermost protective layer 650, such as corrosion-resistant steel wire ropes, is needed instead for

reinforcing the ocean bottom cable. An end-termination 610 at each end of the active section 600 is used for coupling either to the tow cable 710 or to the end-termination of another active section to form the seismic streamer 500.

Although specific embodiments have been illustrated and described, it will be obvious to those skilled in the art that various modifications may be made without departing from what is intended to be limited solely by the appended claims.

CLAIMS

What is claimed is:

1. An electronics-carrying module in a seismic data acquisition cable including:

an electronics carrier having access means for providing an easy-to-reach access to a wrap-around circuitry fitted inside a curved space within said electronics carrier;

a pair of rigid end-fittings spaced apart axially by said electronics carrier for connecting to a section of said seismic data acquisition cable; and

an axial hole formed in said electronics carrier and said rigid end-fittings defining said curved space between said axial hole, said access means and said rigid end-fittings, said axial hole is formed for accommodating a cable with an un-interrupted strength member along said seismic data acquisition cable through said electronics-carrying module.

2. The electronics-carrying module in accordance with Claim 1, wherein said electronics carrier further comprises:

an inner tube enclosing a major portion of said axial hole and having at least one opening thereon for connecting said wrap-around circuitry to said cable for both power and signal transmission.

3. The electronics-carrying module in accordance with Claim 2, wherein said access means comprises:

a first fractional fluid-resistant tube fixed between said pair of

rigid end-fittings; and

a second fractional fluid-resistant tube joined to said first fractional fluid-resistant tube by sealing means so as to form said curved space between said inner tube and said access means, said second fractional fluid-resistant tube can be de-attached from said first fractional fluid-resistant tube by removing said sealing means.

4. The electronics-carrying module in accordance with Claim 3, wherein said first fractional fluid-resistant tube is larger in volume than said second fractional fluid-resistant tube.

5. The electronics-carrying module in accordance with Claim 3, wherein said first fractional fluid-resistant tube is smaller in volume than said second fractional fluid-resistant tube.

6. The electronics-carrying module in accordance with Claim 3, wherein said first fractional fluid-resistant tube is equal in volume to said second fractional fluid-resistant tube.

7. The electronics-carrying module in accordance with Claim 3, wherein said sealing means comprise an elastomer ring such as rubber ring.

8. The electronics-carrying module in accordance with Claim 3, wherein said sealing means comprise a waterproof sealant.

9. The electronics-carrying module in accordance with Claim 7 or 8, wherein said sealing means further comprise a plurality of securing

means selected from the group consisting of screw, clip, band, magnet, suction and adhesive material.

10. The electronics-carrying module in accordance with Claim 2, wherein said access means is a movable open-ended cylinder having a diameter slightly larger than said section of said seismic data acquisition cable so that said movable open-ended cylinder can be slid away from said inner tube to expose said wrap-around circuitry, said movable open-ended cylinder is attached to said pair of rigid end-fittings by means of sealing and can be de-attached by removing said means of sealing.

11. The electronics-carrying module in accordance with Claim 10, wherein said sealing means comprise an elastomer ring such as rubber ring.

12. The electronics-carrying module in accordance with Claim 10, wherein said sealing means comprise a waterproof sealant.

13. The electronics-carrying module in accordance with Claim 11 or 12, wherein said sealing means further comprise a plurality of securing means selected from the group consisting of screw, clip, band, magnet, suction and adhesive material.

14. The electronics-carrying module in accordance with Claim 2, wherein said inner tube is a cylindrical tube.

15. The electronics-carrying module in accordance with Claim 2,

wherein said inner tube is a polygonal tube.

16. The electronics-carrying module in accordance with Claim 2, wherein said wrap-around circuitry comprises:

a first circuit board with a connection for connecting said wrap-around circuitry to said cable through said opening; and

means for securing said first circuit board to said inner tube.

17. The electronics-carrying module in accordance with Claim 16, wherein said wrap-around circuitry further comprises at least one second circuit board joined to said first circuit board by a connection means.

18. The electronics-carrying module in accordance with Claim 17, wherein said wrap-around circuitry further comprises a plurality of other circuit boards joined one to another to said second circuit board by said connection means.

19. The electronics-carrying module in accordance with Claim 18, wherein said connection means comprise a bendable conductor selected from the group consisting of a bunch of wires in a ribbon cable and a flexible printed circuit board.

20. The electronics-carrying module in accordance with Claim 18, wherein said connection means comprise a fixed connector such as a pin-socket.

21. The electronics-carrying module in accordance with Claim

16, wherein said first circuit board is a rigid circuit board.

22. The electronics-carrying module in accordance with Claim 16, wherein said first circuit board is a flexible circuit board.

23. The electronics-carrying module in accordance with Claim 17, wherein said second circuit board is a rigid circuit board.

24. The electronics-carrying module in accordance with Claim 17, wherein said second circuit board is a flexible circuit board.

25. The electronics-carrying module in accordance with Claim 18, wherein said plurality of other circuit boards are rigid circuit boards.

26. The electronics-carrying module in accordance with Claim 18, wherein said plurality of other circuit boards are flexible circuit boards.

27. The electronics-carrying module in accordance with Claim 1, wherein said wrap-around circuitry comprises an amplifying circuitry.

28. The electronics-carrying module in accordance with Claim 1, wherein said wrap-around circuitry comprises a data acquisition unit.

29. The electronics-carrying module in accordance with Claim 1, wherein said wrap-around circuitry comprises an analog-to-digital converter.

30. The electronics-carrying module in accordance with Claim 1, wherein said wrap-around circuitry comprises a multiplexing circuitry.

31. The electronics-carrying module in accordance with Claim 1, wherein said wrap-around circuitry comprises a data transmission unit.

32. The electronics-carrying module in accordance with Claim 1, wherein said wrap-around circuitry comprises an active control circuitry.

33. The electronics-carrying module in accordance with Claim 1, wherein said wrap-around circuitry comprises a power supply circuitry.

34. The electronics-carrying module in accordance with Claim 1, wherein said section of said seismic data acquisition cable comprises:

a portion of said cable; and

an outermost protective layer around said portion of said cable for protecting said cable from the outside environment.

35. The electronics-carrying module in accordance with Claim 34, wherein said rigid end-fitting is connected to said section of said seismic data acquisition cable by clamping said outermost protective layer to said rigid end-fitting.

36. The electronics-carrying module in accordance with Claim 34, wherein said section of said seismic data acquisition cable further comprises a buoyant segment formed to fill the void underneath said outermost protective layer for providing a desired buoyancy level.

37. The electronics-carrying module in accordance with Claim 34, wherein said section of said seismic data acquisition cable further comprises a layer of strength reinforcing member above said outermost protective layer, such as corrosion-resistant steel wire ropes.

38. The electronics-carrying module in accordance with Claim 36, wherein said buoyant segment is a liquid material such as hydrocarbon fluid.

39. The electronics-carrying module in accordance with Claim 36, wherein said buoyant segment is a solid material such as polyurethane composite.

40. The electronics-carrying module in accordance with Claim 36, wherein said buoyant segment is a gel-type material.

41. An electronics carrying module including:

a carrier defining a space for housing of electronics;

selectively removable access means disposable onto said carrier so as to provide access to said space;

a pair of end-fittings spaced apart axially by said carrier for connection of said module to a section of a cable;

said cable having an axially extending strength member; and

a hole disposed along said module between said end-fittings, said hole being sized so as to accommodate threading of said cable through said module such that said strength member extends axially through said module;

said access means being operable to provide access to said space without decoupling or removing the module from the cable.

42. An electronics carrying module according to claim 41 wherein said carrier has a substantially cylindrical outer surface.

43. An electronics carrying module according to claim 42 wherein said curved space is disposed intermediate said hole and said outer surface.

44. An electronics carrying module according to any one of claims 41 to 43 wherein said electronics is wrap-around circuitry.

45. An electronics-carrying module substantially as herein described with reference to any one of the embodiments shown in the accompanying drawings.

DATED this 25th Day of January 2002
THALES UNDERWATER SYSTEMS PTY LIMITED

Attorney: PHILLIP DAVID PLUCK
Registered Patent Attorney of
The Institute of Patent and Trade Mark Attorneys of
Australia of BALDWIN SHELSTON WATERS

ABSTRACT OF THE INVENTION

An electronic-carrying module, for example for use with a seismic data acquisition cable, is disclosed. The electronic-carrying module of the present invention includes, first, an electronics carrier having access means for providing an easy-to-reach access to a wrap-around circuitry fitted inside a curved space within the electronics carrier. Second, a pair of rigid end-fittings spaced apart axially by the electronics carrier for connecting to a section of the seismic data acquisition cable. And third, an axial hole formed in the electronics carrier and the rigid end-fittings defining the curved space between the axial hole, the access means and the rigid end-fittings.

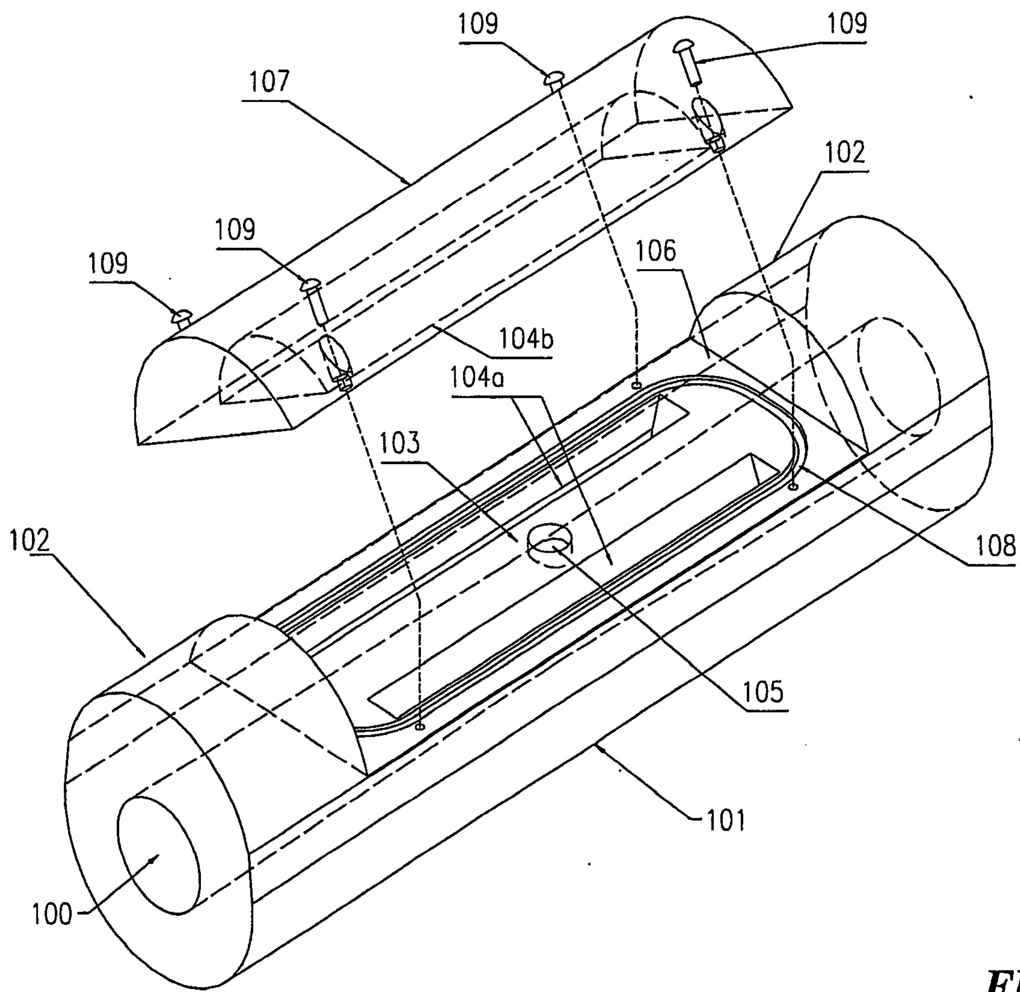

FIG. 1

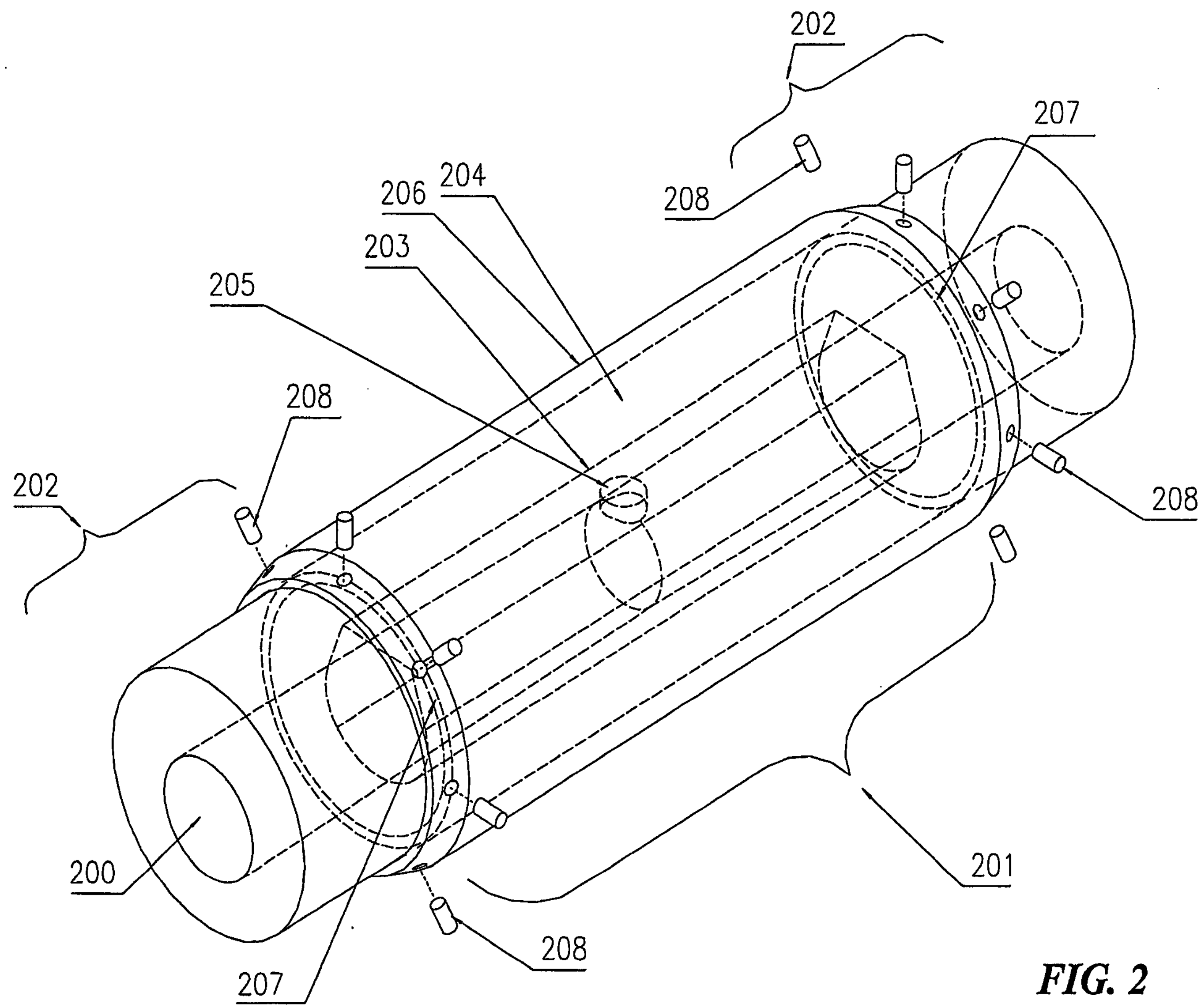

FIG. 2

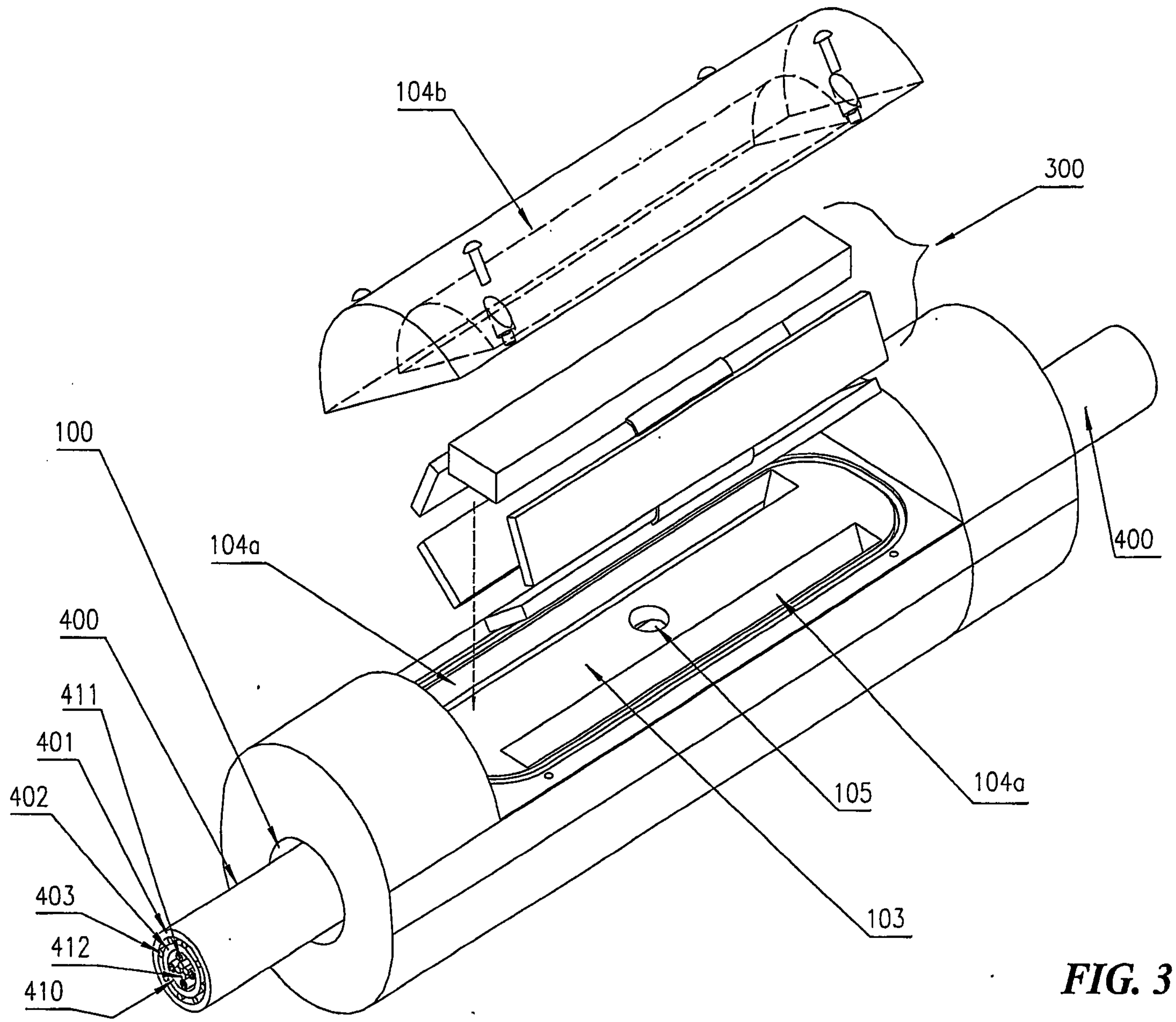

FIG. 3

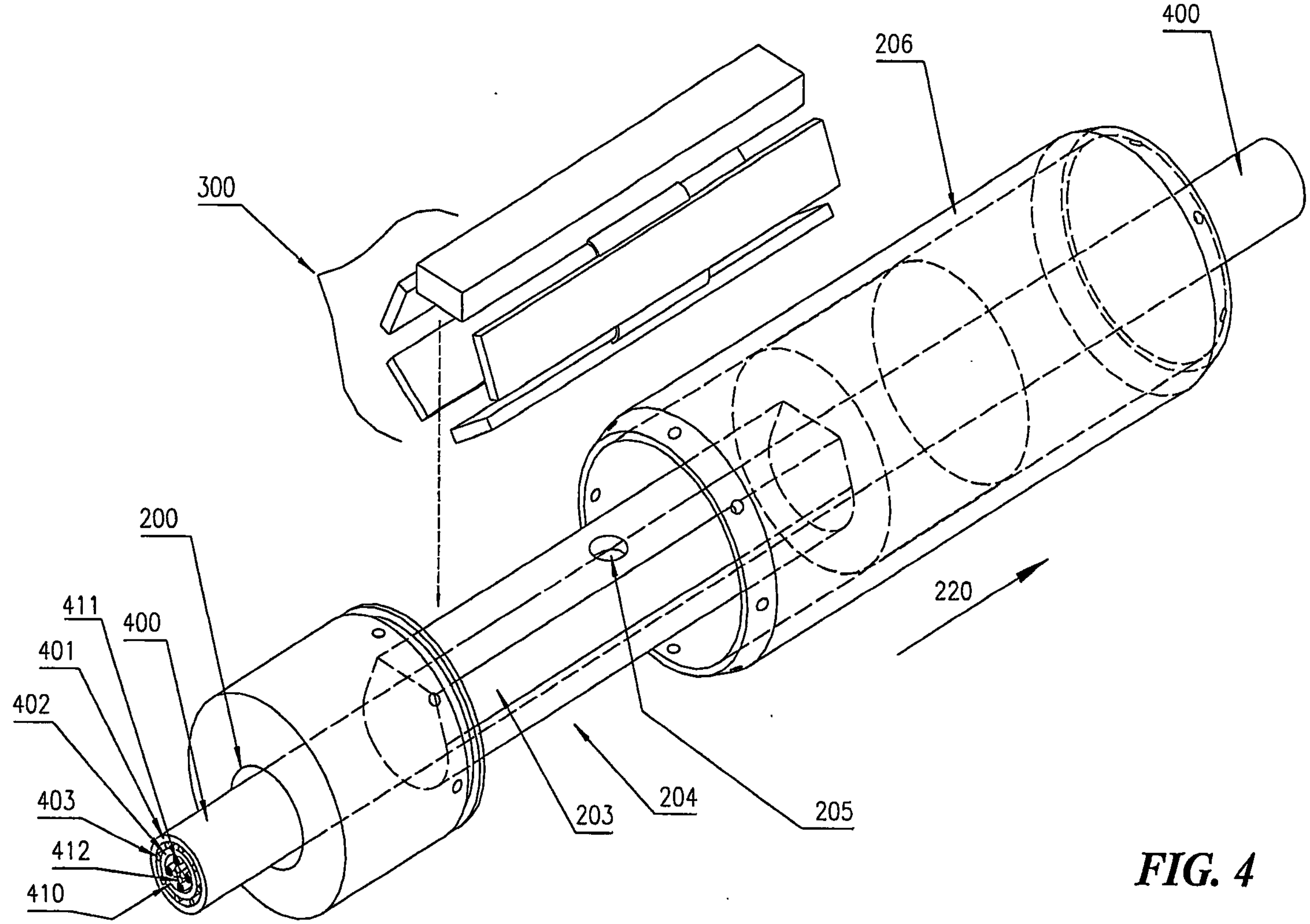

FIG. 4

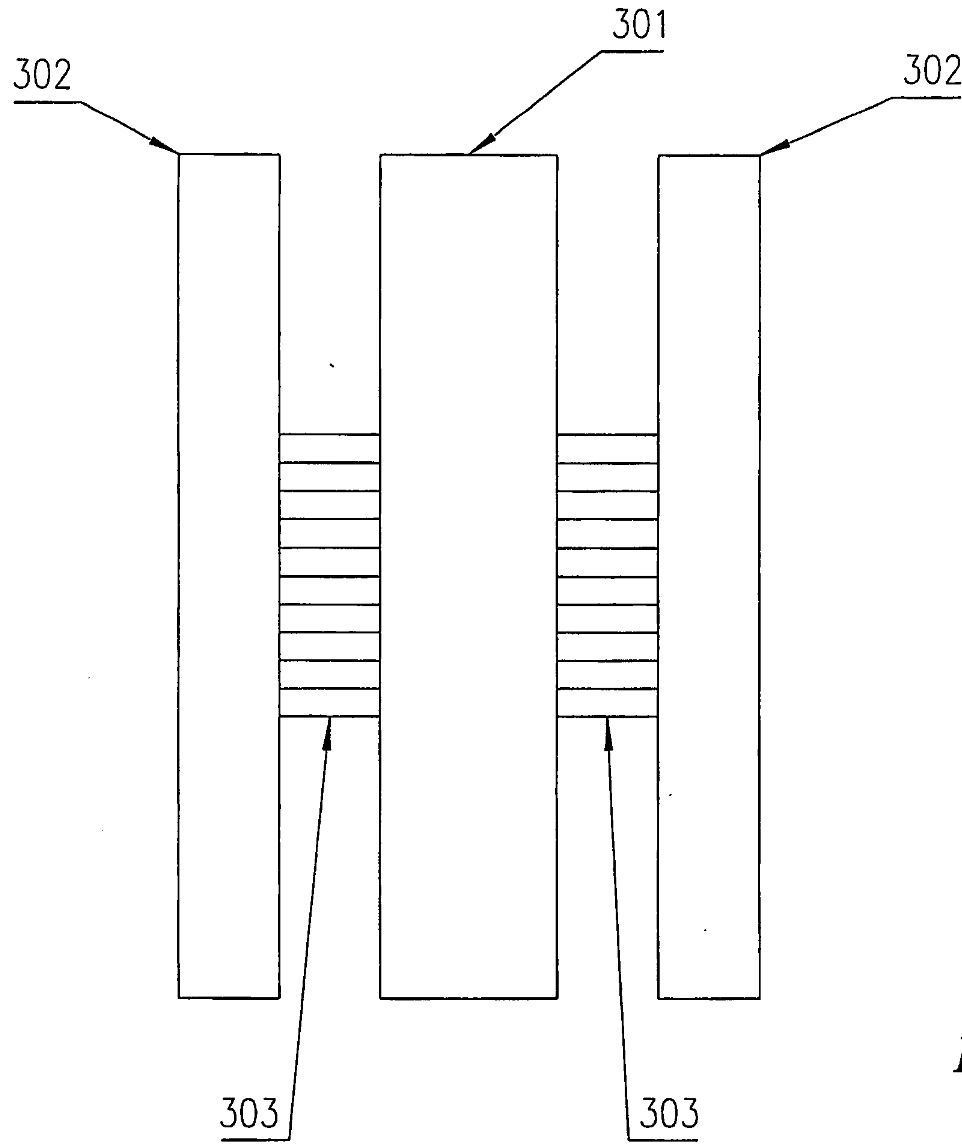

FIG. 5a

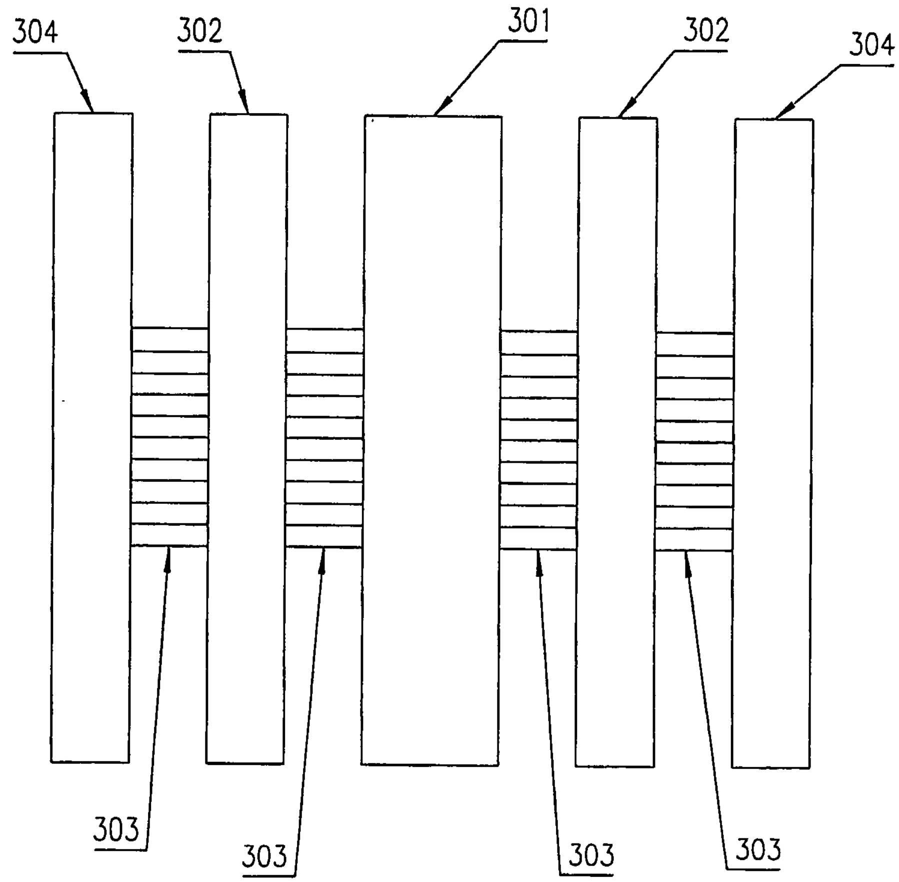

FIG. 5b

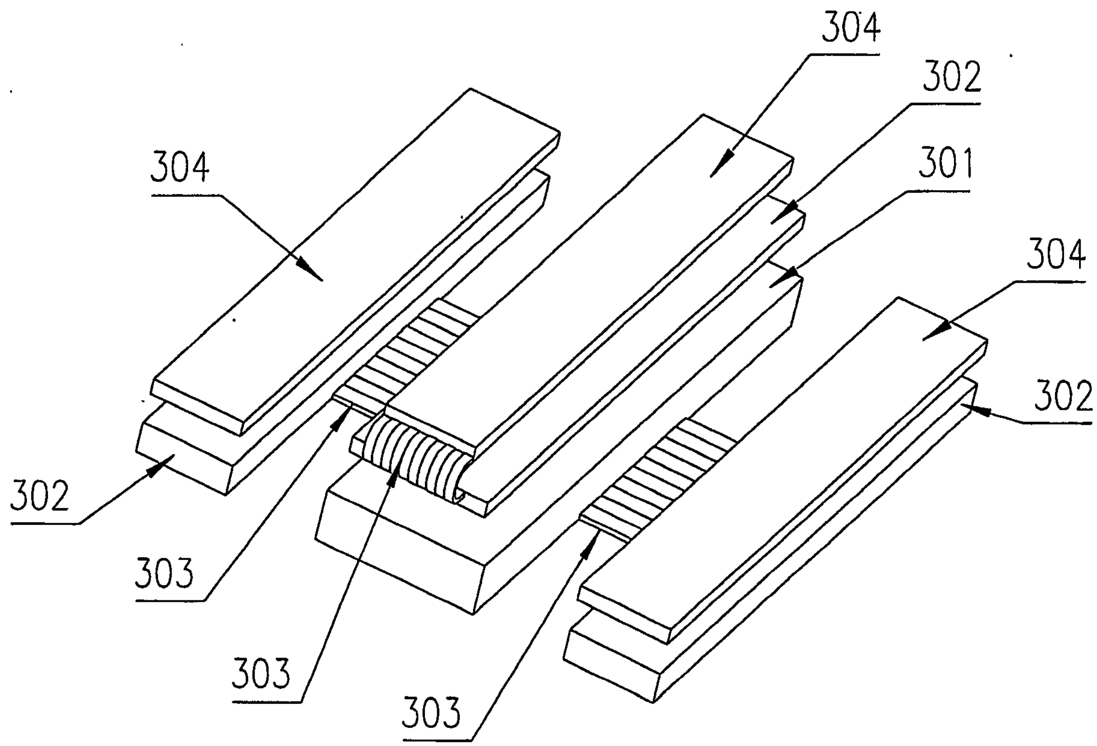

FIG. 5c

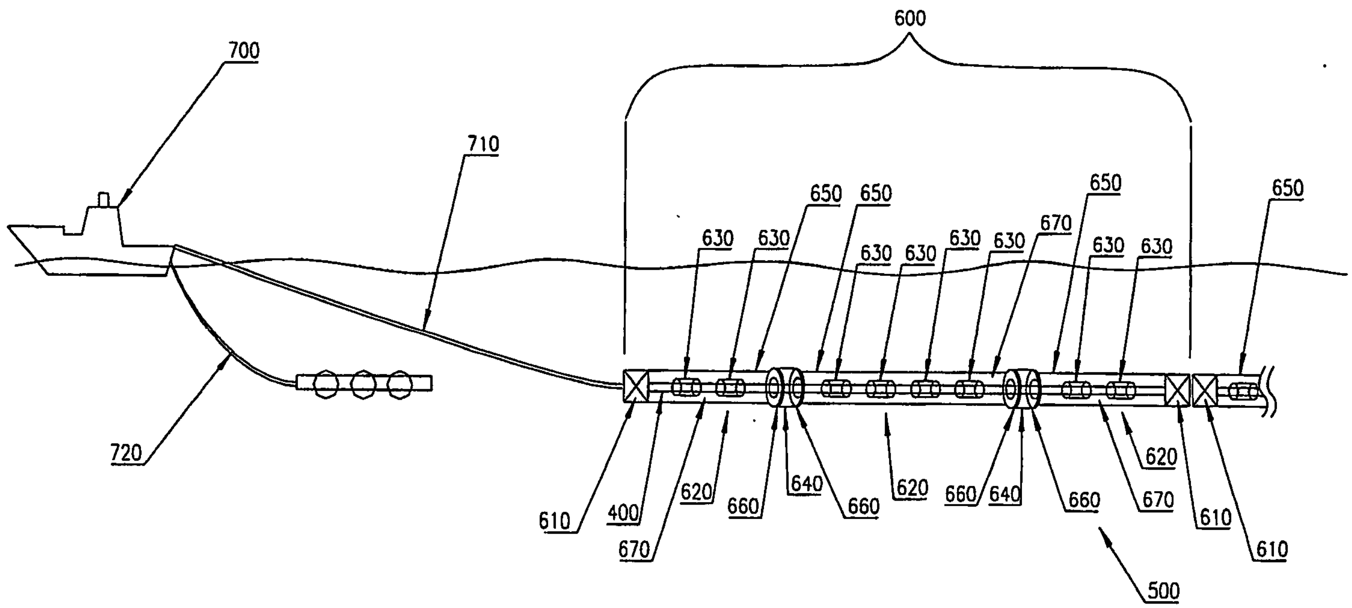
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FIG. 6